Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

SCIENCE AND THE NINETEENTH CENTURY.

By **Ephraim Miller**, of the University of Kansas, Lawrence.

An address delivered at Iola, December 31, 1901, before the thirty-fourth annual meeting of the Kansas Academy of Science.

AT the Battle of the Pyramids, July 21, 1798, the "Man of Destiny" said to his soldiers: "Forty centuries are looking down upon you." In this, the first year of the twentieth century, we need not look back so far to arouse us to action. One hundred years of strenuous life, full of splendid achievement, the nineteenth century is incomparably the most illustrious of all the centennials of time. Its record, from start to finish, is marked by years of substantial growth and progress. It is a century of coal, iron, and steel, of steam and electricity—one in which the human mind has cut loose from the dead weights of the past, to be evermore free from tradition and superstition. Along all avenues of human activity—literature, science, art, architecture, government, trade and commerce, engineering, medical and surgical science, law and theology—the steps of a giant are to be seen.

Eighteen centuries did not accomplish, in the aggregate, what the imperial nineteenth has; nay, even the forty centuries of Napoleon fall far short of it. "From the earliest historic times certainly, if not from the dawn of primitive humanity, down to the present day, the problem of the universe has been the most attractive and the most illusive subject of the attention of thinking men. All systems of philosophy, religion and science are alike in having the solution of this problem for their ultimate object."

The problem is still unsolved. Man at a very early period began to investigate, and in the infant years of his existence "devised three distinct methods" that are, even in our day, persisting with equal tenacity. The first of these is the *a priori* method. It reasons from the subjective to the objective. It requires neither observation nor experiment on the external world. The second is known as the historico-critical method. It depends on tradition, history, direct human testimony, and verbal congruity. It limits observation and experiment to human affairs. The third is the method of science. It begins, in its elements, with observation and experiment. Its early applications were limited mostly to material things. In its subsequent expansion it has gained a footing in nearly every field of thought.

The first has been used by dogmatists, especially the founders and advocates of all fixed creeds, from the atheistic and the pantheistic to the theistic and the humanistic; the second has been used by historians, publicists, jurists, and men of letters; and the third by scientists, astronomers, mathematicians, physicists, naturalists, and, more recently, by anthropologists. The great schools of philosophy and theology of Babylon and Chaldea, of China and India, of Egypt and Athens, could not solve the problem of the universe; man remained essentially barbarian. The story of the first sixteen centuries of the Christian era reveals decaying empires, vice in its most hideous forms, crime of the most appalling character, ignorance and brutality, Neros and Caligulas. Here and there a dim light might be seen. In 1257 Roger Bacon was sent to Paris, where he was closely confined for several years, because he had ventured to attack the old philosophy. In 1592 Bruno was burned for his denunciation of Aristotle, and his advocacy of truth, lead where it might. In 1633 Galileo was forced by the inquisition to abjure the Copernican theory. Ostracism, torture, fire and death were the rewards that men of science received in those days. The common notion was that a laboratory was a place in which the truth-seeker was supposed to receive help and inspiration from the devil. Free thought was heresy, and to investigate nature's mysteries was a diabolical crime.

Discouraging as all this was to men of science, nothing could prevent the onward movement that had already been made. The fall of Constantinople in 1452; the discovery of the art of printing in 1456; the gift of a new world to mankind in 1492; the publication of the Copernican system of astronomy in 1543; the invention of the telescope by Galileo in 1609, with which he discovered the moons of Jupiter and the rings of Saturn; the announcement of Kepler's three laws of planetary motion in 1609 and 1618; the immortal works of Sir Francis Bacon at the beginning of the seventeenth century, in which he did not hesitate to ridicule the philosophy of Aristotle, on the ground, first, that it yielded no fruit, second, that its only service was for useless disputation, and third, that the end it proposed was a mistaken one; the discovery, in the seventeenth century, of the calculus, the most powerful instrument of calculation in the whole range of mathematics; the announcement by Newton in 1685 of the universal law of gravitation; the discovery of oxygen by Priestley in 1774, and the creation of the science of modern chemistry by Lavoisier, were the principal steps taken, few and far between, in order to reach the majestic work of the nineteenth century. Poetry and art, literature and theology, politics and war, were the chief factors in the world's life.

Books and libraries were to be found in the monasteries and in possession of royal families. They were not for men at large. Their civilizing and refining influences failed to reach the masses. Look at Italy, under her reigning popes and princes, talented, learned, and scholastic, and in possession of the best literature and art of the ages; look at France and Spain and Germany, too, with their Bourbons and Charles the Fifths; look at England, under her Roses, Plantagenets, and Stuarts—how much advancement was made by those nations in a thousand years? Villari, an Italian historian, in his "Life and Times of Savonarola," gives a glowing picture of Lorenzo de Medici, ruler of the city of Florence from 1469 to 1492. He says, in his first volume, that Lorenzo "was the typical man of his age—all his qualities were confined to his intellect; his courteous manners were the result of mental refinement, not of kindness of heart; his patronage of the learned was born of his passion for culture, and also because he found it a pleasant pastime, and one useful to his influence as a ruler. After hours of strenuous labor over some new law framed to crush any lingering remains of liberty, or after passing some new decree of confiscation or sentence of death, he would repair to the Platonic academy and take part in heated discussions on virtue and the immortality of the soul; then go about the town to sing his ribald songs in the company of dissolute youths and indulge in the lowest debauchery. After this he would return home, receive great scholars at his table, and vie with them in reciting verses and discoursing on the poetic art. All literary men of any note in Florence gathered round Lorenzo. And both at the meetings held in his own house and those of the renowned Platonic academy, his genius shone amidst this chosen band, while his literary culture gained no little nourishment from their intercourse." Under him Florence "was a continuous scene of revelry and dissipation." "What was most visible at the time was the general passion for pleasure, the pride of pagan learning, the increasingly sensual turn, both of art and literature, under the fostering hand of the man who was master of all in Florence."

What the historian has depicted in such glowing language as being true in Florence was more or less true of many other cities of Europe. All ranks of society, with glorious exceptions here and there, were in a frenzied condition, gone mad with revelry and rottenness. The centuries came and went, and still the pall of the ages hung over man, with but few signs of ever being lifted. Herodotus and Homer, Socrates and Plato, Praxiteles and Phidias, Virgil and Horace, and other mighty names in poetry and art, were read and admired and exalted to the heavens in the midst of revelry and debauchery.

The end, however, was coming. Near the close of the eighteenth century two almost contemporary events occurred. Like a flash of lightning from a clear sky they startled thinking men. These were the American revolution, and the French revolution of 1793. No more tradition, no more Aristotle, no more hair-splitting casuistry of the churchman. The imperial power of science and the laboratory was henceforth to change this old world. The sovereign century had come, and man the sovereign had also come. The horizon of human life, thought and activity has been widely extended since the world discovered a hundred years ago that "the great forces of nature are neither sacred nor profane, neither kind or cruel; that they neither love nor hate, and that they are more unchangeable than the stars; that shrines and temples, priests and priestesses, tripods and oracles, have been in vain, except so far as they reached the human heart and satisfied its natural craving for the worship of the Supreme Being. Instead of building a temple to the far-darting Apollo, or to Zeus, the thunderer, we now stretch over our cities a network for artificial lighting; and all the winds that blow and all the waters that flow are made to furnish their tribute to our comfort and pleasure. We tap the sources of endless energy and transmit it through all the ramifications of our social order, relieving mankind from heavy burdens and creating hundreds of occupations hitherto unknown." A change of front has taken place all along the line. This does not mean that the past is to be buried in oblivion by any means. All that has come to us out of the past that is permanently fine and essential to high thinking and well doing, the epics of Homer, the philosophy of Plato, the splendid drama of Job and the Psalms of David must continually "live, imperishable monuments of the youth of the world."

Let Aristotle go; let the hair-splitting casuistry of the schoolmen be forgotten; let the hide-bound dogmas of the old theologians be cast to the moles and the bats; our modern life stands for the best, and our intellectual activities give promise of still nobler things. "The defenders of the Johnsonian programs delight in the use of unworthy epithets with which to characterize the tendency of modern education; they plead for *humanities* as though anything human was foreign to our curriculum." What can be more human than human life as we see it and as we share it? What problems can be more human than those which face nine out of ten of the people who reach the age of individual responsibility?

Francis A. Walker, late president of the Massachusetts Institute of Technology, in his remarks at the dedication of the new science and engineering buildings at McGill University, Montreal, said:

"The notion that scientific work was something essentially less fine and high and noble than the pursuit of rhetoric and philosophy, Latin and Greek, was deeply seated in the minds of the leading educators of America a generation ago. We can hardly hope to see that inveterate prepossession altogether disappear from the minds of men who have entertained it. Probably they will have to be buried with more or less of their prejudices still wrapped about them, but from the new generation scientific and technical studies will encounter no such obstruction, will suffer no such disparagement. Let us now consider for a few moments the story of the nineteenth century, and as the picture passes before our eyes accord to it the honor due to such splendid achievements.

The one great, masterful event that came in with the nineteenth century was the invention of the steam-engine. This marvelous machine, for the space of a hundred years, has been one of the masterpieces of scientific thought. It is the force that propels thousands of floating palaces over all the waters of the world; that transports the commerce of continents from ocean to ocean; that handles machinery so deftly that a hundred thousand separate and distinct parallel lines can be engraved upon an inch of highly polished steel; that furnishes to the busy world one hundred thousand horse-power; that runs countless looms and mills, furnaces and factories. It annihilates time and space, and gives to the laboring man full employment. The benefits that have accrued to the race from the use of the steam-engine are beyond computation. Closely connected with it is the man who stands by its throttle, the engineer. Go where we may, upon land and upon sea, and in the bowels of the earth, there you will find him—a man of science, an inventor, a whole-hearted gentleman. Look at his achievements! See the transformation produced by the Suez canal in the shortening of the paths of commerce and of travel, and the comforts accruing therefrom. Imagine, if you please, the wonderful impetus that will certainly be given to all the interests of the great republic, by the construction of the Nicaragua canal. An American engineer will, ere long, do it. Consider, for a moment, those triumphs of engineering skill, the great steel bridges, the cantilever bridges, the tunnels that perforate mountain barriers, and the ocean grayhounds, surpassing all the wonders and splendors of ancient Carthage, Egypt, and Athens. Every enterprise of the engineer, whether the construction of a bridge, of a tunnel, of a ship, of a house of twenty-five stories with its steel frames, or of a Corliss engine, is an advance agent of prosperity, progress, and peace. Homer, Shakspere, or Milton, Balzac, George Eliot, or Thackeray, cannot inspire one with beautiful thoughts or purify the fountains of life more than can a Corliss engine at work with its ponderous machinery, and silently, mysteriously and with the least possible friction doing its work, and turning out products of unsurpassed variety, beauty, texture, utility, and value. Here, surely, is a civilizer as potent as anything that ever came from poet's brain or novelist's dreams.

The science of chemistry is another of the great factors of human progress, a veritable child of the nineteenth century. Chemical analysis stops at no obstacle, shrinks from no difficulties, examines what we eat and tells us what we shall drink, liquifies common air, pronounces upon the purity of drugs, unravels the mysteries of nature, and blesses mankind in all the functions of life.

The medical practitioner has need of the chemist. The lawyer summons to his aid the chemist to unravel the difficulties of criminal jurisprudence; chemists for the mines, for the sugar-mills, for the manufacture of colors; chemists for everything.

In the problem of life upon earth, chemistry has become the handmaid of nearly all the other physical sciences. Physics, astronomy, biology, botany, and that most bitterly fought of all modern theories, evolution, are more or less indebted to chemistry for the firm foundation upon which they rest.

What would now be thought of an instructor in science advising his students to shun the writings of Darwin as false and dangerous? Yet not many years ago such was the case. The theory of evolution is an established fact. It teaches in no uncertain way, and beyond controversy, that the survival of the fittest is a law established by the Almighty that is as regular and immutable as that other law, that the attraction of two bodies varies directly as their masses and inversely as the squares of their distances. "The Origin of Species by Natural Selection," announced by Darwin in 1863, proved, as well as anything can be proved, the variations in species, and at the same time pointed out their causes. By a single stroke, the old theories of special creations and cataclysmal changes in the crust of the earth were pushed aside to give way to a philosophy based upon true scientific lines. Closely associated with chemistry and evolution—and a child of the nineteenth century also—is the science of biology, another term that has been held up to ridicule and derision; and yet it has been established beyond doubt by microscopical analysis that all organic life, whether animal or vegetable, is the result of cells, and that protoplasm is identical in plants and animals. At this point biology receives help from the chemical laboratory. Infinitely little things as well as infinitely large ones are examined with attention and profoundest thought; and it is all done, not in the interest of controversy, but that the truth may be reached. The microbe, the cell, the atom, the light from a distant star, the composition of the star itself, the number of vibrations of light, of heat, of sound, and the very essence of things, are studied by the scientist of all lands. Countless millions of stars are added to the galaxy, the parallaxes of stars are measured, and the size and velocity of atoms of gas are estimated with a degree of certainty that is marvelous.

"The middle ages covered Europe with cathedrals of unsurpassed beauty and grandeur, but made no new discoveries to lighten the toil or increase the comfort of the race." Only about ten practical discoveries and inventions of the first magnitude were made from the dawn of history to the beginning of the nineteenth century. These were alphabetical writing, Arabic numerals, printing, the barometer and thermometer, the mariner's compass, the telescope, the steam-engine, which belongs more properly to the nineteenth century, gunpowder, the screw, and the wheel. To the nineteenth century eighteen such inventions and discoveries belong—railways, steamships, electric telegraphs, the telephone, Lucifer matches, gas illumination, electric lighting, photography, the phonograph, the Roentgen rays, spectrum analysis, anesthetics, antiseptic surgery, vaccination, the cotton-gin, the typewriter, the sewing-machine, and the self-binding reaper. To these may be added Pasteur's solution of the process of fermentation, the various methods employed in the liquefaction of gases by intense cold, the organization of great hospitals, public and private, conducted upon the most highly approved scientific and sanitary principles, great schools for the scientific study of poverty and crime, discoveries along geographic and geologic lines, and the complete transformation from the old methods to the modern laboratory method. Such is a part of the inheritance bequeathed to the twentieth century by the demise of the nineteenth. The laboratory is the great revealer. Out of it comes the truth. Under its relentless power error and superstition are crushed. History, literature, metaphysics, and art, poetry and theology, even science itself, must submit to the keen scalpel of the laboratory. According to one writer, the "philologist must have the aid of the physiologist to unravel the problem of human speech; the philosopher, also, in order to explain the workings of the human brain." "With pick and shovel the archæologist has brought to light the ancient civilization of Egypt, and the implements of primitive man." "He has dug out the Ilium of Priam, and laid bare the Roman forum, and read from the clay tablets the language of the Assyrians." By him the history and life of the mound-builders and cliff-dwellers of North America are coming to the light.

In literature, also, the century stands unrivaled. With perhaps the single exception of poetry, there is nothing in the past that can approach in beauty, purity, diction and style the prose, the philosophy, the romance and the history of the writers of the nineteenth century. Such singular preeminence is not to be found in any of the writings of previous centuries. What has caused such a marvelous change? The answer is easily given. The laboratory method, supplemented by scientific criticism.

Eighteen centuries were devoted to the classics of Athens and Rome, the philosophy of Aristotle, and the controversies of the schoolmen, and yet how slow were the steps of progress, how comparatively fruitless the results! To be sure, the world would be a loser if the masterpieces of ancient literature and their benign influence upon the thought and life of succeeding ages were blotted out of existence. The great schools of this country are widening their curricula immensely, especially in the direction of the sciences. The number of students devoted to the pursuit of special and general scientific culture shows most conclusively that "the exalted character of a man's work is to be measured by its usefulness to mankind." Changing the language somewhat, an eminent scientist and scholar has said that "the scientist is by nature an iconoclast. He has small respect for the traditions. He bows not down to the 'tyranny of the ancients.' His glories are in the future. He looks forward, not back. He does not hesitate to smile at the puerile fancies of people who created gods and demigods in order to account for phenomena which to-day submit to mathematical analysis, and which bear no comparison with the exploits of modern science. The accomplished scientist generally reciprocates such prejudice, for he cannot understand how the worship of the ancients can be really serious; it seems to him three-fourths affectation." Technical, scientific and liberal branches in the past have been separated. Now they work side by side, each rendering the other valuable assistance. Science has revolutionized the old and effete systems, and opened wide the door of knowledge and of life.

In the heavens, in the earth, air, and sea, above, below, around, everywhere, science has cast her keen, observing eyes; intelligence has multiplied beyond all computation; the comforts and conveniences of life have increased a thousandfold; nature has been compelled to yield wealth, health, strength, and power, and a better and sweeter life from thousands of fountains that had never before been opened and whose existence had never been dreamed of.

Science is the great truth-seeker, the great truth-finder. The record of the nineteenth century is closed, but some of its problems are still waiting for solution. Will the new century meet the problems and answer them? Will not chemistry, biology, evolution, physics and astronomy bring to the light a marvelous array of new principles and facts not yet dreamed of? Already the answers are coming—are here. A Frenchman has built a machine by which he has shown beyond doubt that aerial navigation has at last been accomplished. Not long will it be until the American will be able to enter his aerial ship from his front door-step and cross to Europe in two or three days. An Italian has caused the telegraph companies of to-day to shake with fear at the bare suggestion of wireless telegraphy.

How long will it be before we shall communicate with the people of our neighboring planet, Mars?

Who, in the light of the past few years, does not see in the electrical appliances of to-day the promise of immensely greater results? Is it not possible that electricity may be the cause of light, heat, and ethereal vibrations, and of all chemical and physical forces?

May not the play of electricity extend from sun to planet, from star to star, changing nebulæ into stars, and stars back again to nebulæ?

But who can peer into the future? Who reveal the secrets that science will bring to light in the next hundred years?

Out of the universal matrix will come knowledge resplendent with honor and glory. The Almighty has so ordained it, and in His own good time His omni-science will bring to view the hidden mysteries of nature.